

# PATENT SPECIFICATION

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## DRAWINGS ATTACHED

- (21) Application No. 41412/69 (22) Filed 19 Aug. 1969
- (23) Complete Specification filed 7 Aug. 1970
- (45) Complete Specification published 1 Nov. 1972
- (51) International Classification B28B 1/26
- (52) Index at acceptance B5A 2B2 2D1X 3F
- (72) Inventors PETER ROBERT KIDD and JOHN ERNEST COPPOCK



## (54) THE PRESSURE CASTING OF OBJECTS IN LIQUID-PERMEABLE MOULDS

- (71) We, DOULTON & CO. LIMITED, a British Company, of Doulton House, Albert Embankment, London, S.E.1., do hereby declare the invention, for which we pray that a patent may be granted to us, and the method by which it is to be performed, to be particularly described in and by the following statement:—
- This invention relates to the pressure casting practices by developing a pressure casting machine employing a horizontally separating male and female mould arrangement. In working on such an arrangement we have discovered in addition a particularly convenient way of adapting the arrangement for delivery of the finished "green" product from the machine, by mounting one of the mould portions in a pivotable manner such as to allow

## SPECIFICATION NO 1295055

By a direction given under Section 17(1) of the Patents Act 1949 this application proceeded in the name of THE BRITISH CERAMIC RESEARCH ASSOCIATION, a Body Corporate organised under British Law of Queens Road, Penkhull, Stoke-on-Trent, Staffordshire.

THE PATENT OFFICE

R 16706/6

- "female" portion. In accordance with normal practice in non-pressurized slip casting, the female portion of the mould is arranged below the male portion on a horizontal supporting surface. With the two portions of the closed mould thus arranged, and with slip supplied under high pressure to the interior space of the mould, the two mould portions are held together by means of a vertically acting hydraulic ram pressing downwardly upon the male portion of the mould. The ram is used also to raise the male portion from the female portion for removal of the cast product on completion of the casting process. In working on the development of machines for carrying out such high-pressure slip casting, we have found that such a vertically-acting machine capable of working at the necessary high pressures, to produce certain types of product, would tend to be inconveniently tall, particularly for installation in the low-roofed buildings commonly used hitherto in the ceramics industry. Accordingly, we have conceived the idea of breaking away from normal casting
- between the first and second mounting structures (with such first and second mould portions thereon) so as to close the liquid-permeable mould for use in a pressure casting process and open it on completion of the casting process, the said first mounting structure including a mould support member pivotally attached to a carrier member so as to allow the first mould portion (attached to the said mould support member) to be pivoted through substantially 90° relative to the carrier member, when the mould has been opened at the end of the process, in such a manner as to allow the cast product of the process to fall freely from said first portion of the liquid-permeable mould.
- It is possible to construct a high-pressure ceramic slip casting machine embodying the invention which is not inconveniently tall and which facilitates automatic ejection of a cast green product, onto a conveyor system below the said one of the two mould portions, followed by recycling of the machine.
- Reference will now be made, by way of

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## (54) THE PRESSURE CASTING OF OBJECTS IN LIQUID-PERMEABLE MOULDS

(71) We, DOULTON & CO. LIMITED, a British Company, of Doulton House, Albert Embankment, London, S.E.1., do hereby declare the invention, for which we pray that a patent may be granted to us, and the method by which it is to be performed, to be particularly described in and by the following statement:—

This invention relates to the pressure casting of objects in liquid-permeable moulds.

It has been proposed to make "green" ceramic products by injecting a ceramic slip into a closed liquid-permeable mould under a sufficient pressure maintained for a sufficient time to expel the liquid of suspension and substantially the whole of the shrinkage liquid from the slip through the liquid-permeable material of the mould, so that on removal of the product from the mould substantially no subsequent shrinkage of the product occurs.

In an apparatus previously suggested for carrying out this proposal, the mould is made in two portions, a "male" portion and a "female" portion. In accordance with normal practice in non-pressurized slip casting, the female portion of the mould is arranged below the male portion on a horizontal supporting surface. With the two portions of the closed mould thus arranged, and with slip supplied under high pressure to the interior space of the mould, the two mould portions are held together by means of a vertically acting hydraulic ram pressing downwardly upon the male portion of the mould. The ram is used also to raise the male portion from the female portion for removal of the cast product on completion of the casting process. In working on the development of machines for carrying out such high-pressure slip casting, we have found that such a vertically-acting machine capable of working at the necessary high pressures, to produce certain types of product, would tend to be inconveniently tall, particularly for installation in the low-roofed buildings commonly used hitherto in the ceramics industry. Accordingly, we have conceived the idea of breaking away from normal casting

practices by developing a pressure casting machine employing a horizontally separating male and female mould arrangement. In working on such an arrangement we have discovered in addition a particularly convenient way of adapting the arrangement for delivery of the finished "green" product from the machine, by mounting one of the mould portions in a pivotable manner such as to allow that mould portion to be rotated to a position from which the cast green product can fall freely from that mould portion, for example onto a conveyor system below the machine.

According to the present invention there is provided a pressure casting machine, comprising a first mounting structure for supporting a first portion of a liquid-permeable mould, a second mounting structure for supporting a second portion of the said liquid-permeable mould, and motive means coupled with at least one of the first and second mounting structures and operable to bring about substantially horizontal relative movement between the first and second mounting structures (with such first and second mould portions thereon) so as to close the liquid-permeable mould for use in a pressure casting process and open it on completion of the casting process, the said first mounting structure including a mould support member pivotally attached to a carrier member so as to allow the first mould portion (attached to the said mould support member) to be pivoted through substantially 90° relative to the carrier member, when the mould has been opened at the end of the process, in such a manner as to allow the cast product of the process to fall freely from said first portion of the liquid-permeable mould.

It is possible to construct a high-pressure ceramic slip casting machine embodying the invention which is not inconveniently tall and which facilitates automatic ejection of a cast green product, onto a conveyor system below the said one of the two mould portions, followed by recycling of the machine.

Reference will now be made, by way of

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example, to the accompanying diagrammatic drawings, in which:—

Figure 1 shows a side elevation of the greater part of a high-pressure slip casting machine, embodying the present invention, for use in the solid casting of lavatory (water-closet) cisterns,

Figure 2 illustrates, by means of a partly cut-away and sectioned view, an alternative disposition of some components of the machine of Figure 1,

Figure 3 shows, to a smaller scale, a plan view of the machine with the said components in the disposition illustrated in Figure 2, and

Figure 4 shows an axial sectional view of one part of a mould used with the machine.

The machine is based upon a frame 1, on an upper surface of which are fixedly mounted two parallel end-plates 2 and 3 which extend transversely across the base frame 1. The end-plates 2 and 3 support respective opposite ends of four parallel guide beams 4. Slidably journaled onto the guide beams 4 is a steel platen 5 which extends parallel to the end-plates 2 and 3 and is connected with a piston rod 6 of a horizontally acting hydraulic ram 7 fixedly supported by the end-plate 3.

The end-plate 2 carries two brackets 8 which project to the rear of the end-plate 2, i.e. to the left as seen in Figure 1, and which support bearings 9 whereby a hydraulic ram 10 is supported so as to be capable of pivoting about a horizontal axis (indicated at 11 in Figure 3).

On the front of the end-plate 2, i.e. to its right as seen in Figure 1, there is mounted a mould support plate 12. At its lower edge the support plate 12 is pivotally connected to the end-plate 2 so as to allow rotation of the plate 12 through substantially 90°, about a horizontal axis, from the disposition illustrated in Figure 1 to that illustrated in Figure 2. At the two opposite ends of the pivotal mounting means along the lower edge of the plate 12 are provided respective rotary unions 16 (Figure 1) of known type, enabling two air/water lines 13 (one shown in Figure 2) to be connected through the end-plate 2 to a duct 14 (Figure 2) formed in the plate 12 and extending along its horizontal axis of rotation. Projecting laterally at intervals along the duct 14 are nozzles 15 (only one of which is visible in the drawings) giving access to the duct 14.

The rearward face of the mould support plate 12 is provided with projecting brackets 17, by means of which the plate 12 is coupled to the piston rod 18 of the pivotally mounted hydraulic ram 10. The end-plate 2 is formed with an aperture 19 (Figure 2) for allowing the brackets 17 and piston rod 18 to pass freely through that end-plate.

Beneath an ejection aperture 32 in the frame 1 is positioned an off-loading device indicated generally at 19 in Figure 2. This device includes a product receiving assembly which

can be raised or lowered in operation and which includes at least one control roller 20, spring-loaded for the automatic operation of a microswitch (not shown) in known manner, to which further reference will be made hereinafter. The off-loading device 19 is associated with a conveyor system 24 (Figure 3) for delivering cast products from the machine.

To set the machine up ready for use, a metal mould casing box 21 is bolted on to the front of the mould support plate 12 in the disposition illustrated in Figure 1. The casing box 21 contains a porous, liquid-permeable, sand-resin female mould portion 22 (Figure 2) of known type, and is formed near its rim with an array of nozzles 23 for passing fluid between the mould portion 22 and the outside of the casing box 21. Fluid delivery lines (not shown) are then connected between the nozzles 23 and the nozzles 15, so as to connect the female mould portion with the air/water lines 13 (Figure 2). The interior form of the female mould portion 22 is of course substantially the exterior form of the required lavatory cistern.

In addition, a male mould assembly 25 is bolted to the front (to the left as shown in Figure 1) of the movable platen 5. The construction of the male mould assembly 25 is illustrated more fully in Figure 4. The assembly 25 includes as the male mould portion proper a porous, liquid-permeable, sand-resin body 26 the external form of which is the required internal form of the lavatory cistern to be cast by means of the machine. The body 26 has itself been cast, in known manner, upon a metal box-like structure 27 which is formed with perforations 28 for allowing fluid to pass between the porous body 26 and the interior of the box-like structure 27. A slip delivery tube 30 extends axially through the assembly, and a base plate 29 is provided for fixing the assembly 25 to the platen 5.

When the assembly 25 has been mounted on the platen 5, a flexible slip supply line (not shown) is connected via the rear of the platen 5 to the rearward end of the tube 30. The manner in which this connection is effected is not illustrated particularly in the drawings, but would obviously give no difficulty to any competent engineer in this field. Similarly, an air/water line (not shown) is connected through the platen 5 to communicate with the interior space of the box-like structure 27.

The working cycle of the machine is controlled by an automatically operative electrical system of relays and timers (not shown). The construction of such a system will not be described in detail since it would clearly be a routine matter to any competent electrical engineer on reading the required functions as specified hereinafter.

At the commencement of the working cycle the platen 5 is moved forward horizontally, by the ram 7, so that the male mould portion

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26 becomes inserted in the female mould portion 22 and the mould is firmly closed under a clamping pressure of about seventy tons. A similar balancing pressure, intended to reduce possible bowing of the plate 12 through the aperture 19, may be applied to the rear of the plate 12 by means of the ram 10. On closure of the mould thus, a slip supply valve (not shown) is triggered to allow slip at a workshop supply-line pressure, for example in the range from 40 p.s.i. to 80 p.s.i., to pass through the tube 30 into the cistern-shaped cavity between the male and female mould portions. When this cavity has been filled with slip, the pressure on the slip is increased to about 500 p.s.i. This high slip pressure is maintained for a predetermined time sufficient substantially to ensure that both the water of suspension and the shrinkage water is forced from the aforesaid cavity into the sand-resin mould portions. The expression of water during this period generally necessitates the supply of one or two pints of additional slip via the tube 30. During this period also, a vacuum (about 12 p.s.i. below atmospheric pressure) is applied through the lines 13 (Figure 2) and nozzles 23 to the exterior of the female mould portion, and also to the interior of the box-like structure 27 within the male mould portion. This vacuum assists in the removal of water through the air/water lines whereby the vacuum is applied, and in particular is believed to assist in ensuring satisfactory "scavenging" of water from the porous mould portions. The period during which the high pressure is maintained in the slip amounts to about 3 minutes, the rest of the working cycle taking about 2 minutes.

At the end of the high-pressure period a "dump valve" (not shown) opens, for about  $1\frac{1}{2}$  seconds, to lower the pressure in the slip supply lines by releasing a small quantity of surplus slip therefrom. The aforesaid slip supply valve is closed, any counter-pressure applied by the ram 10 is released, and, while the vacuum is maintained on the female portion of the mould, the vacuum on the male portion of the mould is replaced by positive air pressure, in the range from 80 p.s.i. to 100 p.s.i., supplied to the interior of the box-like structure 27 so as to blow back some moisture to the surface of the male mould portion 26 and thereby assist release of the male mould portion from the interior of the cast product. The ram 7 acting by way of its piston rod 6 pulls the platen 5 rearwardly so as to open the mould by withdrawing the male mould portion from the female mould portion, leaving the cast product in the female portion of the mould.

The hydraulic ram 10, acting through its piston rod 18, then causes the plate 12 to rotate forwardly through  $90^\circ$  so as to place the female mould 22 in the disposition illustrated in Figure 2, the off-loading device 19

having previously caused its receiving assembly to rise to a position a short distance (of the order of one inch, for example) below the mouth of the female mould portion 22. Thereupon, the vacuum applied through the lines 13 to the female mould portion is replaced by an air pressure of about 20 p.s.i. (higher pressure might cause the base of the cast product to cave in), so as to assist release of the product from the female portion of the mould. Accordingly, the cast product 31 falls out of the female portion of the mould onto the receiving assembly of the off-loading device. The action of the weight of the cast product upon the spring-loaded roller 20 thereupon causes the aforesaid micro-switch to operate so as to instigate lowering of the receiving assembly, with the cast product thereon, to a position clear of the underside of the frame 1. The cast product is then delivered laterally from the machine onto the conveyor system 24 (Figure 3).

The ram 10 subsequently acts to return the plate 12, with the female part of the mould, to the disposition illustrated in Figure 1, whereupon the working cycle can be repeated as often as is desired, the resulting green products being delivered by the conveyor system 24 for further processing, as necessary to produce the finished cisterns.

The mould casing box 21 houlding the female mould portion may be a pressure-compensated casing.

It will be appreciated that the machine can be adapted for use in hollow casting, for example in the production of water-closet basins, in which case provision is made in the working cycle for the drainage of surplus slip from the cast product in routine manner.

In practice it is generally preferred to have a flat carrier plate, or board, placed on the receiving assembly of the off-loading device 19. The green product is thus released onto the carried plate, which is then passed with the product to the conveyor system 24. Another carrier plate is then placed on the receiving assembly, for the next green product, and so on. The carrier plate is not shown in the drawings, for the sake of clarity.

#### WHAT WE CLAIM IS:—

1. A pressure casting machine, comprising a first mounting structure for supporting a first portion of a liquid-permeable mould, a second mounting structure for supporting a second portion of the said liquid-permeable mould, and motive means coupled with at least one of the first and second mounting structures and operable to bring about substantially horizontal relative movement between the first and second mounting structures (with such first and second mould portions thereon) so as to close the liquid-permeable mould for use in a pressure casting process and open it on completion of the casting

process, the said first mounting structure including a mould support member pivotally attached to a carrier member so as to allow the first mould portion (attached to the said mould support member) to be pivoted through substantially 90° relative to the carrier member, when the mould has been opened at the end of the process, in such a manner as to allow the cast product of the process to fall freely from said first portion of the liquid-permeable mould.

2. A machine as claimed in claim 1, wherein the said motive means comprise a hydraulic ram mounted on a further mounting structure and coupled with the said one of the first and second mounting structures for causing it to move relatively to the further mounting structure.

3. A machine as claimed in claim 2, wherein the said one of the first and second mounting structures is the second mounting structure.

4. A machine as claimed in any preceding claim, further comprising additional motive means mounted on the said carrier member and coupled with the said support member and operable to control the position of the support member as regards movement, about its pivotal axis, relative to the carrier member.

5. A machine as claimed in claim 4, wherein the said additional means comprise a further hydraulic ram which is so mounted as to be capable of pivoting relatively to the carrier member about a horizontal axis.

6. A machine as claimed in claim 4 or 5, wherein the additional motive means is arranged to apply a compensating pressure to the said support member thereby to counteract outward bowing of a base part of the first mould portion during the pressure casting process.

7. A machine as claimed in any preceding claim, in combination with such first and second mould portions, being female and male portions respectively of a two-portion liquid-permeable mould, mounted respectively on the first and second mounting structures.

8. A machine as claimed in any preceding claim, further comprising an off-loading device extending below the said carrier member for receiving such cast product, when it falls from the first mould portion, and conveying it from the receiving position for further processing, the device including a spring-loaded member arranged to yield, when such cast product is received thereon, so as to operate an electrical switch for initiating the conveying action of the device.

9. A machine as claimed in any preceding claim, in combination with supply ducting for delivering a ceramic slip (as the said castable material) into the closed mould so as to fill it initially at a workshop supply pressure, and a pressure-intensifying device connected with the supply ducting for increasing the slip pressure in the filled mould to a value that is high in relation to the said workshop supply pressure.

10. A pressure casting machine, substantially as hereinbefore described with reference to Figures 1 to 3 of the accompanying drawings.

11. A pressure casting machine as claimed in any preceding claim, in combination with air and water supply and removal means and with electrical control circuitry arranged and connected for operating the machine automatically in accordance substantially with the working cycle hereinbefore described with reference to Figures 1 to 4 of the accompanying drawings.

12. A ceramic slip pressure casting process, carried out by means of a machine as claimed in any preceding claim.

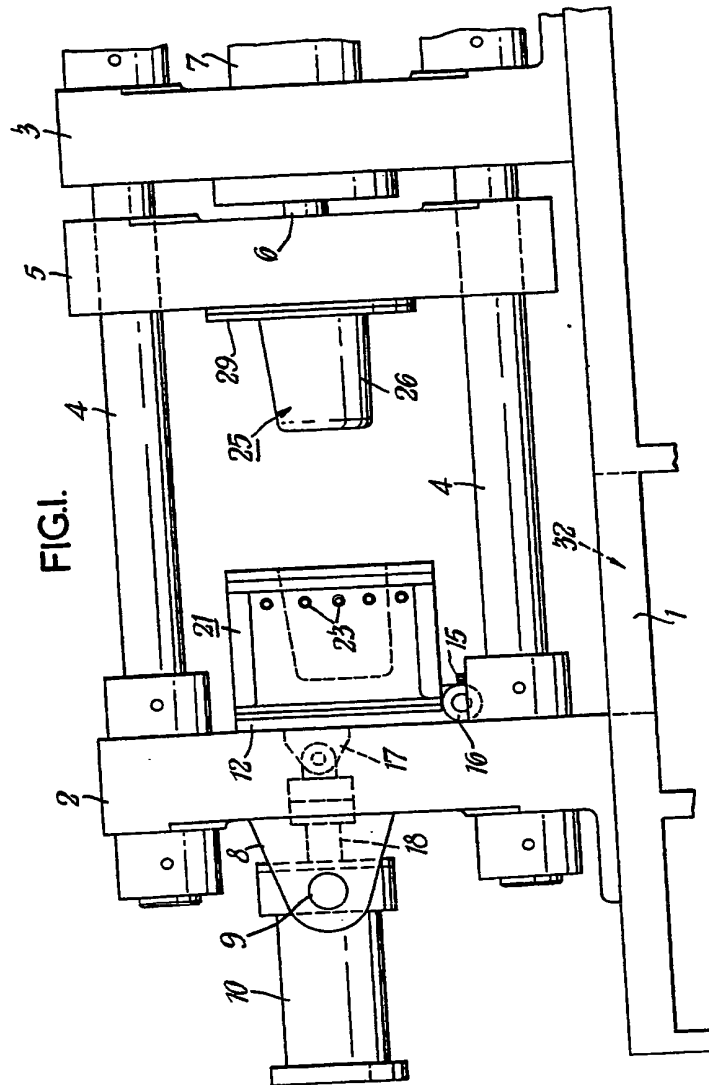
13. A cast product made by a process as claimed in claim 12.

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COMPLETE SPECIFICATION

This drawing is a reproduction of  
the Original on a reduced scale

**FIG. 1.**



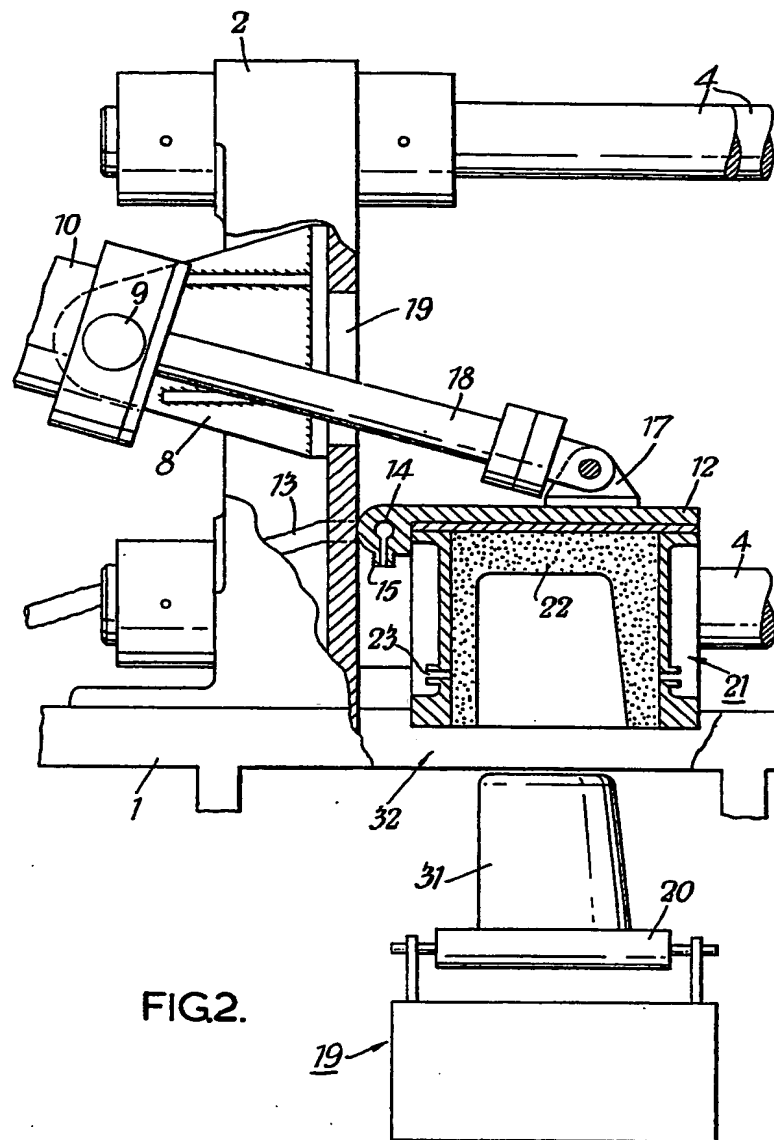
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3 SHEETS

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Sheet 2



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Sheet 3

FIG.3.

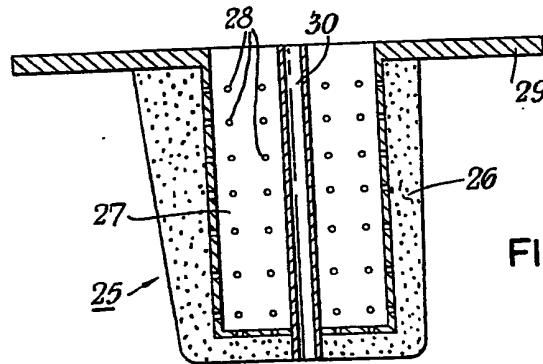
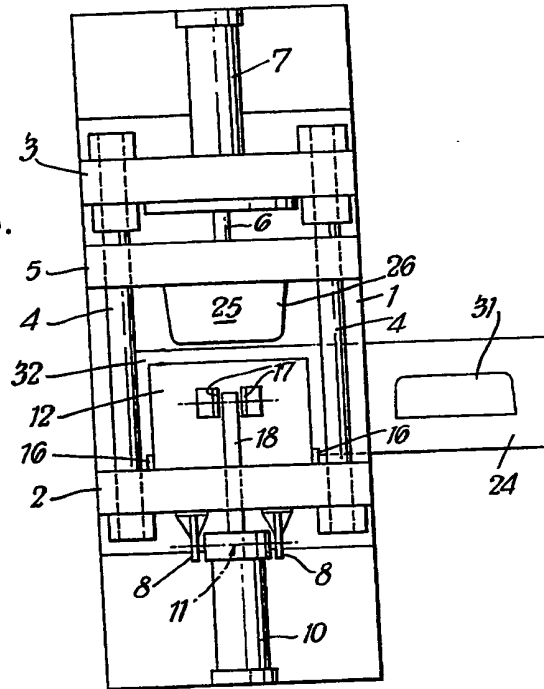


FIG.4.